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DRAFT

INSTITUTE REPORT

on

Introducing Basic Science Concepts to Primary Grade Visually Handicapped Students

held at

American Printing House for the Blind
Louisville, Kentucky
October 7-9, 1971

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June 1, 1972

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* Session at APH

PROGRAM OF INSTITUTE

Primary Science Institute

American Printing House for the Blind
Louisville, Kentucky
October 7-9, 1971

Thursday		At APH
	8:00 - 9:00	Tour of the Printing House
	9:15 - 10:00	Welcome, Introductions, Purpose of the Institute
	10:30 - 12:00	Presentation of Primary Science Materials Which have been field tested, Discussion
	1:15 - 2:30	Presentation of Simple Machines Prototypes, Discussion
	2:30 - 4:30	Discussion of Overlaps in Primary Science and Primary Mathematics Curricula
Friday		At Seelbach
	8:00 - 10:00	Physical Science--General Session
	10:00 - 12:00	Small Group Sessions (Groups A, B, and C)
	1:30 - 3:30	Life Science, Earth Science--General Session
	3:30 - 5:00	Small Group Sessions
Saturday		
	8:00 - 10:30	Reports from Small Group Sessions
	10:30 - 12:00	Overall Summary Session

Please note that first day sessions will be held at the American Printing House for the Blind, 1839 Frankfort Avenue, and sessions on Friday and Saturday will be held at the Seelbach Hotel.

Morning and afternoon breaks will be taken between sessions.

The Primary Science Institute was held to inspect the Primary Science Laboratory, to examine concept areas in science where deficits are believed to exist, to identify aids for introducing specific concepts at the primary level, and to suggest priorities for developing the instructional aids necessary for completing the Laboratory. Concept areas which are more appropriate for individual projects were also designated.

Introduction

The purpose of the Primary Science Laboratory is to make possible the introduction of basic science concepts earlier and more effective than is now possible. The proposed Laboratory is summarized in APPENDIX A for those who may not be familiar with the project.

The thermometer, the basic cell, and an insect unit were developed and field tested in public and residential school programs as a pilot program to determine the feasibility of assembling a primary science laboratory. These apparatus were listed among the instructional aids recommended for production in the report of the previous Science Institute (APH, 1970).

The Primary Science Institute participants were asked to inspect component parts of the Laboratory. Following examination and discussion, the teachers were requested to make suggestions for further adaptation of the apparatus. A discussion outline was provided to assist in their decision making. Suggestions and recommendations were recorded.

Discussion outline

Participants were asked to examine the contents of the Laboratory and to specify additional apparatus for its completion for field testing.

The following questions were suggested to stimulate discussion.

1) Do you have suggestions for further modification of any of the apparatus included in the Laboratory? Apparatus? Adaptations?
   a) Which of the basic cell models should be included in the Laboratory, the "regular" cell or the "pull-apart" cell? Why?
   b) Other?
2) Are you aware of additional apparatus or aids (e.g. light probe) which should be included? What are they?
   a) We plan to include a three-dimensional plant model (exterior view) in the Laboratory. What comments or suggestions do you have on the complexity/simplicity of this model?
   b) Other?
3) What basic science concepts can each of these apparatus be used to introduce?
4) Are any of these aids already available? Can any of these be included in the list of supplementary aids to be appended to the instructional program?
5) Do any of the aids require development or adaptation? How extensive?
6) What is the minimum information an instructional program included in the Laboratory must provide? (Note: The instructional materials in the Laboratory have been designed to permit maximum flexibility for use in existing instructional programs and curricula.)

7) What are your recommendations on the basis of the above considerations?

Description of the laboratory

The apparatus included in the laboratory were suggested on the basis of:

1) Recommendations from the participants in the Science Institute held at APH, 1970, and
2) Results of extensive curriculum analyses of several series of science textbooks, including those available on quota from APH.

Curricular goals, on three levels, introduce each instructional program which accompanies each apparatus. Within this frame of reference, each program focuses on teaching concepts necessary for interpretation and discrimination of tactual and chromatic cues. For example, the instructional program for the basic cell teaches the blind student how to utilize areal symbols in identifying the layers of the basic cell (outside wall, inner wall, body or protoplasm, and nucleus). The teacher then is able to incorporate the cell into a relevant science unit or instructional program.

The following apparatus were presented for examination.

The thermometer. The thermometer was selected because adequate understanding and use of this instrument is essential for satisfactory comprehension of numerous concepts in life science, earth science, and physical science. A general purpose thermometer was recommended by the Science Institute (APH, 1970) for use in elementary science experiments. A tactile dial thermometer for non-vision students was developed (Franks,

1970) and was found to be a practical and effective instrument for teaching basic concepts in temperature and phase change in matter to non-vision students in grades 4-12.

Since the thermometer is introduced in the science curriculum in the primary grades, instruction in its use for young visually handicapped students is essential if these students are to achieve on a level comparable to sighted students. A complicating factor for young non-vision students is the array of point, areal, and linear, symbols embossed on the face of the dial thermometer. Participants felt that the use of the dial thermometer could be greatly facilitated at the primary grade level if the identification and discrimination of these symbols could be taught to young non-vision students.

Results of the preliminary field testing indicated that the primary grade students can discriminate the point, areal, and linear symbols appearing in the discrimination exercises. Younger students required more time to read the key and experienced some difficulty in reading the thermoform representations of the thermometer face.

The following suggestions were made for completing adaptations of the thermometer.

1) The tactile thermometer should be available from APH as an item separate from the Primary Science Laboratory to facilitate use by older students. For protective purposes, a lid or cover should be designed for the face of the dial thermometer.
2) The tactual discrimination exercises which introduce the symbols on the face of the thermometer, should be included with the ther-

mometer. Participants viewed these exercises as very helpful since the exercises can be used to introduce the symbols before presenting.

The basic cell. The previous Science Institute (APH, 1970) established that an enlarged pull-apart basic cell was needed. The purpose of the basic cell is to introduce the parts of the cells by emphasizing chromatic and tactual discrimination of likeness and difference of surface areas.

Although the pull-apart cell has not been tested with primary grade students (A vacuum-formed, non-pull-apart cell was pilot tested.), informal evaluation has been quite positive. Four primary grade students demonstrated a preference for the pull-apart cell when compared to the non-pull-apart cell. The Institute participants also preferred, and unanimously endorsed, the pull-apart cell.

The following suggestions were made for completing adaptation of the basic cell:

1) The pull-apart cell should be produced. Advantages offered by the pull-apart cell are:
   a) More tactually and chromatically discriminable components
   b) More realism--plastic-rubber has more life-like qualities
   c) Increased utility--can be used as a plant or animal cell
   d) Removable pieces--outer layer and nucleus are removable
   e) High motivation aspect
2) The tactile and/or chromatic discrimination exercises should accompany the basic cell.
3) The cell cover should be included.

The insect. The insect unit, recommended by the previous Science Institute, was also noted in Baird's analysis (1971) of primary grade science books. The insect unit was developed and pilot tested:

1) to determine the students ability to observe and to note differences and likenesses in insects,
2) to teach body parts of the insect, and
3) to reinforce identification of the insect and to show that the insect is different from other lower animals.

The advantage of the unit is its immediate availability in a climate and/or time when attempts to obtain live insects might be futile. Because these animals are larger-than-life size, their body parts are easily identified.

Institute participants liked the insect unit and suggested no modifications. They recommended that the insect unit should be produced without braille or large print labels.

Simple machines

Inspection of primary science textbooks confirms the fact that increasing numbers of physical science concepts (e.g. work, energy, friction) are appearing in the primary science curriculum. Although a set of simple machines (Bettinger, 1970) have been developed for older visually handicapped students, no set of machines is available for introducing basic physical science concepts to young visually handicapped students. The development/adaptation of a set of simple machines for introducing basic physical science concepts to young visually handicapped students (utilizing the inclined plane or ramp, the lever, the wedge, the screw, the pulley, and the wheel and axle) is in process. This set of machines

was presented in an Institute session for inspection.

The inclined plane or ramp. The inclined plane is introduced at the primary grade level as a ramp. A ramp is a machine used to do work. A ramp is a flat surface which is higher at one end than at the other end. It is easier to move a load up a ramp than to lift the same load. A long ramp makes work easier than a short ramp. The higher one end of a ramp is, the greater the force needed to move a load up the ramp. No measurement activities using the ruler or spring balance are included in the introduction of the inclined plane.

The following suggestions were made for completing adaptation of the inclined plane.

1) A removable retainer should be placed before the wheel of the inclined plane to keep the cart from jumping the wheel and falling over the edge. The retainer should be removable for use with older students.
2) The cart should have two side panels added. With only end panels to contain them, weights can slip off the cart distracting younger students. The side panels should be lower than the end panels.

The lever. The lever is introduced without reference to first class, second class and third class levers, although various activities demonstrating the positioning of force, fulcrum, and resistance appear in primary textbooks. The lever with its two bars can be utilized to demonstrate tactually, the visual illustrations in the textbooks.

The following suggestions were made for completing adaptations on the lever.

1) A balance arm that really balances should be included.

2) Provision should be made on the balance arm for the use or accommodation of weights.

The wedge. The wedge was accepted as presented with the suggestion that the slopes be made more gradual for introduction to young students. The end of a screw driver, the axe edge, the knife edge, and other wedges can be introduced when appropriate.

The screw. The large wooden APH bolt with nut will be included to introduce the concept of the screw. The threads are large enough that they can be inspected tactually by young students. The concept that a screw is an inclined plane can be presented when students are mature enough to comprehend the concept.

The pulley. This apparatus was adapted to demonstrate the fixed and the movable pulley, and to teach the concepts 1) that a fixed pulley helps us move a load by pulling or applying force in the direction opposite that in which the load is moving, and 2) that a movable pulley moves along with the load being lifted and requires less force than a fixed pulley.

The following suggestions for completing adaptations on the pulley were made.

1) Modifications should be made on the apparatus to simplify introduction of concepts using the fixed and the movable pulleys.

2) The positioning of one pulley should not interfere with the operation of the other pulley.

3) Some provision for attaching a weight to the movable pulley should be made.

The wheel and axle. A wheel and axle work together to do work. A load can be lifted and/or lowered using the wheel and axle.

The following suggestions were made for completing adaptations on the wheel and axle.

1) The axle will operate more efficiently if it is shortened.
2) An additional cross notch on the axle elevation control will provide additional stationary positions.

The participants of the Institute made the following overall recommendations on simple machines

1) The set of simple machines, with adaptations suggested above, should be included in the Primary Science Laboratory.
2) The set of simple machines should be made available also as a set apart from the Primary Science Laboratory.
3) A vice should be included to provide a means of stabilizing the base of some of the machines. (A vice also is a simple machine.)
4) The instructional sheets accompanying the simple machines should include the purposes or objectives of the machines and sufficient information to allow the teacher to feel comfortable in intooducing the machines to primary grade students. However, it is recommended that the machines be used in conjunction with the regular class textbook or instructional program.

Additional concept areas considered

Suggestions were made for providing educational materials in the following concept areas.

1. Chemistry. A variety of simple experiments are performed at the primary grade level in which the primary student can participate. Activities using the light probe can provide the non-vision student direct interaction in a number of concept areas which at present are not available to him. The light probe received the single highest priority of an additional aid to be included in the Laboratory. Further discussion is included elsewhere in this report.

2. Weather. It was recommended that a weather kit be developed for teaching weather concepts introduced at the elementary grade level. The kit might include several or all of the following items.

a) Weather map

b) Weather station

c) Weather vane

d) Anenometer

e) Hygrometer to measure humidity

f) Barometer

g) Humidity table

h) Wind sock

3. Earth science or geology. Three-dimensional models are needed to show stratification of the earth. These can be produced in vacuum-formed models similar to the Landform and Biological models. The Landform models were suggested as supplementary aids to introduce physical features of the earth at the primary grade level.

4. Metamorphosis. Three-dimensional models of organisms illustrating the physical transformation during development after the embryonic state (e.g. the larva of an insect to the pupa and the pupa to the adult, life cycle of the frog) should be developed as a separate kit for use at the elementary level. Some of these models should be simple enough for introduction at the upper primary level. Examination of real specimens, commercially available animal models, and the insect model unit included in the Laboratory can be used for introducing the animals to young students. Because of the time involved in analyzing and researching appropriate models, inclusion of metamorphic models in the Laboratory is not suggested.

5. Sound. Existing materials in sound should be examined in an effort to develop a kit in this concept area for use at the elementary level. Sound can be introduced at the primary level relying on everyday sounds in the environment.

6. Basic plant model. A model including the main parts of plants, similar to the basic insect models, should be developed for primary students.

Priority development list for the Primary Science Laboratory

Participants in the Institute recommended the following aids and apparatus for adaptation and/or development for inclusion in the Primary Science Laboratory.

Light probe. Utilization of the light probe appears to offer new opportunities for introducing laboratory experiences to non-vision students in life science, earth science, and physical science. It was designated as the single highest priority item to be added to the Laboratory.

Most of the participants had not previously examined the light probe nor had they observed its use in performing simple laboratory experiments. A number of introductory activities were suggested for its use with the recommendation that additional laboratory experiences be identified and included in the Laboratory.

Activities suggested for its use included:

1) Measuring levels of colored liquids (and dry measure) using a transparent tactual measuring cup
2) Determining the presence of a flame
3) Measuring the evaporation of colored water in a transparent container
4) Determining the contrast of colors
5) Following the change of the field in simple experiments in magnetism (using iron filings)
6) Detecting changes from light to dark (if a light bulb is on or off)

Plant models. Models representing the two major types of plants--monocots and dicots--were considered necessary additions to the Primary Science Laboratory. Examples suggested to represent the two classes were the bean and corn.

Rain gauge. A simple (transparent) rain gauge should be included in the Laboratory as an aid for introducing a unit on weather. To facilitate examination with the light probe, food coloring can be added prior to measuring the amount of rainfall.

Priorities for non-Laboratory materials

Consideration was given to the need for the development of additional educational materials in science. Although a number of the areas recommended have implications for primary grade students, it was felt these areas could be developed as specific units or kits for use by both primary and elementary grade students. The broad ranges of life science, earth science, and physical science were not explored, but only those that were out-growths of, or were suggested by, the primary science information and materials presented in the Institute. They include:

1) High priority items
   a) The possibility of developing an ecology laboratory should be explored.
   b) The feasibility of producing educational materials relating to family life and human development (sex education) should be pursued.
   c) Models depicting the stages of metamorphosis should be constructed.
   d) The possibility of developing an improved braille compass should be investigated.
2) Medium Priority:
   a) Aids depicting different classes of animals (including human) should be developed.
   b) Models showing rock formation and stratification should be constructed.
   c) Aids depicting various forms of sea life should be developed.

Over-lapping concept areas in science and mathematics

A study (Baird, 1971) to identify basic concept areas covered in primary science textbooks was reviewed as a guide for identifying concept areas where overlap in science and mathematics occur. This study developed lists of related vocabulary and assembled a series of experiments which can be used to illustrate introductory science concepts. Suggested concept areas follow.

The scientist. This concept area which emphasizes that scientists observe, discuss, read, perform experiments, and keep careful records was considered significant. However, it was suggested that these tasks should be built into all of the appropriate concept areas. Consequently, the need for a specific unit on the scientist (included in the analysis) is not needed.

Temperature. Use of the thermometer in measuring and calculating changes in temperature, gains and losses in energy, and in a number of other operations have relevance for both science and mathematics.

Compass direction. Although the need for a better student compass was expressed, participants felt that teacher made compasses might be utilized for introducing directional concepts at the primary grade levels, particularly in grades one and two.

Simple machines. The simple machines in development appear to be adequate for appropriate mathematics activities which might be introduced at the upper primary grade level (e.g. linear measurement, using the ruler, weight of air using the balance arm on the lever).

Measurement. The importance of the use of the ruler for stimulating interaction of the non-vision student with his environment was noted. Measuring growth of plants was recognized as one activity providing an excellent introduction to the use of the ruler in primary science. A number of other measurement activities can incorporate use of the ruler to reinforce science and mathematics concepts.

Time. A large two dimensional braille sheet showing hand positions for two or three settings of a clock could be made similar to the insect models on plastic. Both round and square faces on the clocks would show pupils that the shape of the clock is not the measuring factor.

Overall Recommendations

1) Existing instructional materials, kits, and individual aids in science available from commercial or specialized distributors should be evaluated to determine their usefulness for blind and partially seeing students. The best representatives of each should be considered for adaptation if they are found to have substantial instructional value for visually handicapped students (e.g. SCIS programs, Xerox science materials, rain gauge, light probe).

2) Instructional aids and materials should be developed which promote the young visually handicapped student's interest and involvement in science.

3) The need for developing three-dimensional aids to which concrete experiences and objects can be tied is emphasized. Such materials are recognized by the Institute as important educational aids to

assist young visually handicapped students in making better transitions from real animals, plants, and objects to the abstract raised-line drawings which attempt to illustrate these in braille textbooks.

4) Simplified "pull-apart models" with a minimum of detail should be considered when developing tactual materials. (See Development of three-dimensional models section.)

5) Do not emboss braille on individual apparatus or materials. If and when this is appropriate, dymotape or other techniques can be used for labeling those parts which the teacher wishes to emphasize. It is felt that in pursuing a one-concept-at-a-time approach, no braille should appear on any apparatus when it is first introduced. Learning to manipulate or utilize an instructional aid should not be complicated by, nor the student distracted by, the appearance of braille characters on the aid.

6) All tangible apparatus and all discrimination exercises should provide both tactile and chromatic coding except for apparatus (e.g. the tactile ruler, the thermometer) developed specifically for non-vision students.

7) Instructional procedures for using instruments and aids developed and/or adapted should be provided for students' use, in braille and in large print when feasible.

8) Teachers' manuals for use of educational aids should be included in the Laboratory.

9) The utilization of cassettes, particularly with older students, should be explored.

10) Tangible apparatus and educational materials displayed at national and regional meetings and at special conferences should be supplemented with demonstrations by professional personnel who are qualified to discuss educational implications of the materials.

11) A general session of the AEVH convention should be devoted to primary science. In the AEVH Science Workshop, the final Report of the Primary Science Institute should be presented with members of the Institute serving as a panel to discuss suggestions and conclusions recorded in the Report.

12) Participants expressed concern and interest in education of visually handicapped students in public and residential school settings, and recognized that visually handicapped students in public school programs integrated in sighted classes may have particular problems in science instruction which should be considered in the development, testing, and evaluation of instructional materials.

13) The extended utilization of APH science (and other instructional) materials in programs for multi-handicapped blind children should be considered.

14) The possibility of utilizing APH science (and other instructional) materials with children who have handicapping problems other than vision should be explored.

15) Participants in the Primary Science Institute agree to cooperate in so far as possible in the realization and implementation of the recommendations made herein.

APPENDIX A

PRIMARY SCIENCE LABORATORY

The following summary is taken from the "Educational Research, Development, and Reference Group Report on Research and Development Activities - Fiscal 1971, American Printing House for the Blind."

The purpose of the primary science laboratory is to introduce basic science concepts earlier and more effectively than is now possible. The laboratory will include the instruments, classroom aids, and instructional materials necessary to teach these concepts. A curriculum analysis (Baird, 1971) was conducted to identify basic concept areas covered in primary science textbooks, to develop lists of related vocabulary, and to assemble a series of experiments and activities which can be used to illustrate the concepts. Educational aids in three of these concept areas, the thermometer, the basic cell, and insects, were developed and field tested in public and residential school programs as a pilot project to determine the feasibility of such a laboratory.

The thermometer was selected because adequate understanding and use of this instrument is essential for satisfactory comprehension of numerous concepts in life science, earth science, and physical science. A tactile dial thermometer for non-vision students previously developed was found to be a practical and effective instrument for teaching basic concepts in temperature and phase changes in matter to such students in grades 4-12. Since the thermometer is introduced in the science curriculum in the primary grades, instruction in its use for young visually handicapped students is essential. A complicating factor in use of this device by young students is the array of symbols embossed on the face of the dial thermometer. It was felt that the use of the dial thermometer could be greatly facilitated at the primary grade level if the identification and discrimination of these symbols could be taught to young students.

The basic cell introduces parts of the cell and emphasizes chromatic and tactual discrimination of likenesses and differences of surface areas. Similarly, the insect unit teaches body parts and encourages inspection of differences and likenesses in tactual models. These aids feature a number of point, linear, and areal symbols which will be used on other materials to be included in the laboratory.

The development/adaptation of a set of simple machines for teaching basic physical science concepts will be pursued. Inspection of primary grade science textbooks confirms the fact that increasing numbers of physical science concepts (e.g , work, energy, friction) are appearing in the primary science curriculum. Although a set of simple machines has been developed for older visually handicapped students, no set of machines is available for introducing basic physical science concepts to young visually handicapped students.

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